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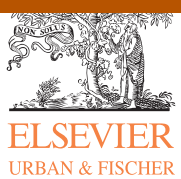

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Intra- and extracranial stenoses in TIA — Findings from the Aarhus TIA-study: A prospective population-based study

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KEYWORDS
Transient ischemic attack;
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Summary
Background: Atherosclerotic stenoses of the intracranial arteries (ICAS) is associated with high risk of stroke after TIA. The prevalence of intracranial stenoses is considered to be low in Caucasians, however population-based data are lacking and only a minority of patients with acute TIA or stroke is evaluated for ICAS.
Methods: We prospectively examined the prevalence of stenoses of the pre- and intracerebral vessels using transcranial colour coded sonography (TCCS) in a population based cohort of all TIA patients in the community of Aarhus, Denmark in the period 1.3.2007—29.2.2008.
Results: The TIA cohort included 203 patients fulfilling the diagnostic criteria for TIA. We examined 195 patients with extra- and intracranial TCCD.

Any stenoses and symptomatic ICAS was found in 12.3% and 8.2%, respectively. The stenoses were located in the intracranial internal carotid artery in 3.6% and 3.1%, anterior cerebral artery in 0.5% and 0%, middle cerebral artery in 4.6% and 2.6%, intracranial vertebral artery in 2.1% and 1.5%, and in the basilar artery in 1.5% and 1.5%, respectively. In comparison, we found any stenoses and symptomatic stenoses in the extracranial carotid artery in 14.4% and 10.8%, and the extracranial vertebral artery in 5.6% and 2.1% of the patients, respectively. Carotid occlusion was found in 3.6%, combined extra- and intracranial stenoses in 4.9%.
Conclusion: The prevalence of ICAS was in this population-based TIA cohort of Caucasians comparable with the prevalence of carotid stenoses. Systematic evaluation for intracranial stenoses should be considered in all patients with acute ischemic cerebrovascular disease.

Introduction

Stenoses in the intracranial vessels (ICAS), caused by atherosclerosis, are associated with a risk of stroke after TIA of 11—23% during the first year [1—3]. The prevalence of ICAS has been reported to be high in east Asian countries including Japan and China, but is supposed to be low in Caucasians

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[4—6]. However, population-based data on the prevalence of ICAS in Caucasian TIA-patients are not available.

In this study, we examined the prevalence of ICAS in a population based purely Caucasian cohort of TIA-patients by using TCCS.[1]

Material and methods

Study setting and design

We conducted this cohort study within the population served by the Department of Neurology, Aarhus University Hospital. The department serves as the only local stroke unit in the Aarhus area, which is clearly defined and mostly urban. The catchment area had 328,542 inhabitants in 2007. The Danish National Health Service provides tax-supported health care for all inhabitants, guaranteeing free access to general practitioners and hospitals. All acute medical conditions including TIA are exclusively treated at public hospitals, either as in or as outpatients.

Identification of TIA patients

We established an acute TIA-team, which served TIA-patients both on the stroke unit and the TIA-clinic. Patients with TIA symptoms during the preceding 48 h or crescendo TIA were admitted directly to the stroke unit and monitored for 1—2 days. All other patients were seen as outpatients 1—3 days after received referral.

TIA was defined as a sudden focal neurologic deficit of presumed vascular origin lasting less than 24 h.

Inclusion criteria were: TIA according to definition, residence in the Aarhus area, TIA during the last six months, and date of referral 1 March 2007—28 February 2008. Patients with a modified Rankin Score (mRS) >2 were excluded. Informed consent was obtained from all participants. All patients fulfilling the inclusion criteria for TIA were registered prospectively, including those admitted for suspected stroke but ending up as TIA.

Patient characteristics

The TIA diagnosis was made by a specialist. Patients underwent a neurological examination (more than 95% of the TIA patients were examined by the first author), CT or MR of the brain, ECG, laboratory tests and ankle brachial index. Furthermore, we performed duplex sonography of the extra- and intracranial vessels (TCCS). All ultrasound examinations were done by one experienced neurologist, performing at least 500 examinations per year and certified by the European Society of Neurosonoly and Cerebral Haemodynamics (ESNCH). Atherosclerosis of the carotid arteries was considered significant if a stenoses $\geq$50% was found (NASCET criteria). Intracranial stenoses were defined according to the criteria established by Baumgartner: stenoses in the anterior (ACA), middle (MCA) and posterior (PCA) cerebral artery was defined by peak systolic velocity of $\geq$120 cm/s, $\geq$155 cm/s, and $\geq$100 cm/s respectively, Stenoses in the VA and BA was defined by peak systolic velocity of $\geq$90 cm/s, and $\geq$100 cm/s respectively [7]. Additionally to these criteria, stenoses in ICA, and the extracranial VA was defined by systolic peak velocity $\geq$120 cm/s. All intracranial velocities were measured with an insonation angle of 0° without angle correction. A stenosis was considered symptomatic if a patient had TIA symptoms during the last six months before inclusion, related to the supply area of a carotid artery with a significant stenosis, or an extracranial vertebral or an intracranial stenosis according to the criteria above. Patients with combined extra- and intracranial stenoses e.g. ICA and MCA-stenoses on the symptomatic side were counted both as symptomatic ICA- and MCA-stenoses.

Hypertension was defined as history of hypertension or antihypertensive treatment, blood pressure systolic >140 mm Hg, or diastolic >90 mm Hg. Hypercholesterolemia was defined as total cholesterol >5.0 mmol/l, LDL cholesterol >3.0 mmol/l, or cholesterol lowering treatment. Diabetes was defined as history or treatment for diabetes, fasting glucose >6.9 mmol/l, or any glucose >10.9 mmol/l. Peripheral artery disease was defined as history of claudication, or ankle-brachial index <0.9.

Our study was approved by the local ethics committee (protocol number 20060188).

Results

We identified 203 patients fulfilling the diagnostic criteria for TIA. The characteristics of the patients are shown in

Table 1 Patient characteristics.

	TIA *N* = 203
Age	66.3 (range 19—93)
Male	109 (53.7%)
Smoking (active)	30.5%
High alcohol consumption	8.9%
Hypertension	71.9%
Diabetes	15.3%
Hypercholesterolaemia (>5 mmol/l)	82%
Atrial fibrillation	8.9%
All cardioembolic causes[a]	15.8%
PAD[b] (history or symptoms)	5.9%
PAD, incl. ABI[c] measurement	19.2%
History of MI[d]	7.4%
History of ischaemic heart disease including MI	12.3%
History of stroke	11.8%
History of TIA	10.4%

[a] Atrial fibrillation, dilated cardiomyopathy, mitral valve prolapse, patent oval foramen.
[b] PAD: peripheral arterial disease.
[c] ABI: Ankel brachial index.
[d] MI: myocardial infarction.

[1] *Abbreviations*: ICAS: stenosis in the intracranial vessels transcranial; TCCS: colour coded sonography; ACA: anterior cerebral artery; MCA: middle cerebral artery; PCA: posterior cerebral artery; VA: vertebral artery; BA: basilar artery; ICA: internal carotid artery.

Table 2 Frequencies of precerebral and intracranial stenoses in 195 TIA patients.

	All stenoses/occlusions (%)	Symptomatic stenoses (%)	Symptomatic occlusions (%)
All extra- and intracranial stenoses ($N = 195$)	27.2% ($n = 53$)	19.5% ($n = 38$)	3.1% ($n = 6$)
Extracranial common/internal carotid artery	16.4 (32)	10.8 (21)	3.1 (6)
Extracranial vertebral artery	5.6 [a] (11)	2.1 [a] (4)	
Intracranial carotid artery	3.6 (7)	3.1 (6)	
Anterior cerebral artery	0.5 (1)	0 (0)	
Middle cerebral artery	4.6 (9)	2.6 (5)	
Posterior cerebral artery	1.5 (3)	0 (0)	
Intracranial vertebral artery	2.1 (4)	1.5 (3)	
Basilar artery	1.5 (3)	1.5 (3)	
All intracranial stenoses	12.3 (24)	8.2 (16)	
Combined extra- and intracranial stenoses	4.9 (10)		

[a] Including one patient with vertebral artery dissection.

Table 1. In 195 patients we conducted TCCS of the pre- or intracranial vessels. In 39 patients the transcranial part of the examination was partly inconclusive due to insufficient bone window. Ultrasound contrast agents were not used in this study. Any stenoses or occlusion and symptomatic stenoses or occlusion was found in 27.2% and 22.6%, respectively. We found extracranial carotid artery stenoses in 14.4% and 10.4%, carotid occlusion in 4.1% and 3.1%, extracranial vertebral artery stenoses in 5.6% and 2.1% (including one dissection), and intracranial artery stenoses in 12.3% and 8.2%, respectively (Table 2).

Discussion

In our population-based TIA study, the prevalence of symptomatic ICAS diagnosed according to TCCS criteria was only slightly lower than the prevalence of symptomatic carotid stenosis. Furthermore, the estimated prevalence of ICAS may even be conservative due to the incomplete intracranial vascular assessment in 20% of the patients.

To the best of our knowledge, no other population-based data on the prevalence of ICAS are available. In the French SOS-TIA study, 1.823 unselected consecutive patients admitted at an acute TIA-clinic were examined with transcranial Doppler, and a prevalence of 8.8% for any ICAS or intracranial occlusion was found. Restricting the analysis in that study to patients defined as with definite TIA or minor stroke, the prevalence of ICAS increased to 11.5%, and about half of them were symptomatic [7].

In Denmark only a minority of patients with acute TIA or stroke is currently evaluated for ICAS. This may be explained by the assumption that intracranial atherosclerotic disease in Caucasians is rare, and by the lack of evidence for a specific treatment. Recently published data provides some evidence for the efficacy of dual platelet inhibition [8], and preliminary data on rapid and aggressive treatment seem to show a reduction of the risk of stroke in patients with TIA and intracranial stenoses [9]. Moreover, intra-arterial stenting may be an option in unstable ICAS not responding to medical treatment, even if this cannot be recommended as standard procedure [10].

Conclusion

The prevalence of ICAS in TIA-patients was substantial in a population-based cohort of Caucasians. The prevalence of symptomatic stenoses or occlusion was almost similar in the precerebral and intracerebral arteries, including a minor number of tandem stenoses in the pre- and intracerebral vessels. We suggest that a systematic screening with ultrasound examination for intracranial stenoses should be considered in all patients with acute ischaemic cerebrovascular disease.

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